Synthesis, properties and structure of solid solutions on the basis of $Bi_2Fe_4O_9$

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The solid solutions based on ferrite $Bi_2Fe_4O_9$ were prepared by a solid-state reactions method. According to the results of X-ray phase analysis it was revealed that $Bi_2Fe_4O_9$ had an orthorhombic structure (sp. gr. *Pbam*) of mullite with lattice parameters a = 7.9595 Å, b = 8.4297 Å, c = 5.9912 Å, V = 401.987 Å^3. At partial isovalent substitution of Bi^{3+} ions by La^{3+} ions, as well as at heterovalent substitution of Fe^{3+} ions simultaneously by Ti^{4+} and Co^{2+} ions in $Bi_2Fe_4O_9$, corresponding solid solutions $Bi_{2-x}La_xFe_4O_9$, $Bi_2Fe_{4-2x}Ti_xCo_xO_9$ are formed. The formation of solid solutions is indicated not only by the results of X-ray diffraction (changing the parameters *a*, *b*, *c*, *c/a* и *V*), but also by the data of IR spectroscopy. At substitution of Bi^{3+} ions by La^{3+} ions in $Bi_2Fe_4O_9$ a shift of the absorption bands to the high-frequency region takes place, which is a consequence of a reduction in the bond lengths Fe–O in the octahedra FeO_6 and decreasing O–Fe–O angles. Analysis of the temperature dependence of the specific magnetization showed that $Bi_2Fe_4O_9$ was an antiferromagnet with T_N = 258 K, and the introduction of La^{3+} ions in the $Bi_2Fe_4O_9$ crystal structure shifts T_N to the low temperature region, and T_N becomes equal to 246 K for $Bi_{1,95}La_{0,05}Fe_4O_9$ and 243 K for $Bi_{1,8}La_{0,2}Fe_4O_9$.

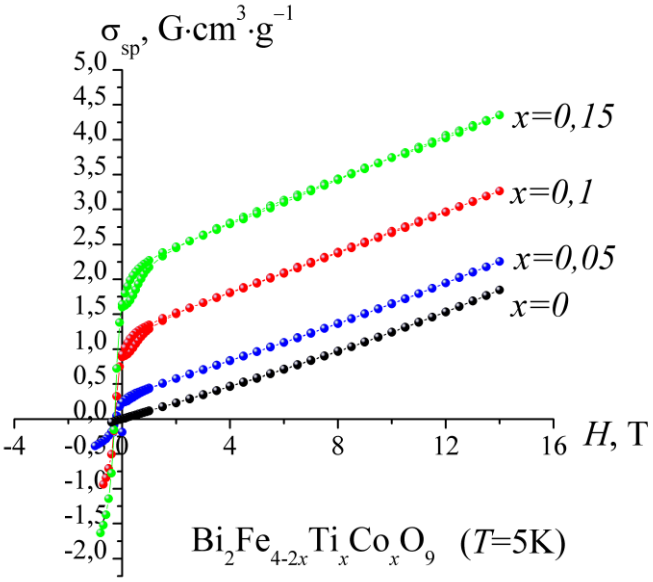

Fig. The field dependence of the specific magnetization (σ_{sp}) of the $Bi_2Fe_{4-2x}Ti_xCo_xO_9$ solid solutions at 5 K

The field dependencies of the specific magnetization for solid solutions based on $Bi_2Fe_4O_9$ were studied at 300 K and 5 K (Figure). The results obtained show the presence of negative exchange interaction in the samples, which leads to an antiferromagnetic arrangement of the magnetic moments of the two sublattices (octahedral and tetrahedral), in which Fe^{3+} ions are placed. The temperature dependencies of the thermoelectric power and thermal expansion were also studied at 300−1000 K.